

**REPORT OF THE  
DEFENSE SCIENCE BOARD  
TASK FORCE**

**ON**

**DEEP ATTACK WEAPONS MIX STUDY  
(DAWMS)**



**January 1997**

**Office of the Under Secretary of Defense for  
Acquisition and Technology**

**Washington, D.C. 20301-3140**

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE <b>JAN 1997</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>Report of the Defense Science Board Task Force On Deep Attack Weapons Mix Study (DAWMS)</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Office of the Under Secretary of Defense for Acquisition and Technology Washington, DC 20301-3140</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>UU</b>	18. NUMBER OF PAGES <b>30</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			



OFFICE OF THE SECRETARY OF DEFENSE

3140 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3140

DEFENSE SCIENCE  
BOARD

MEMORANDUM FOR THE UNDER SECRETARY OF DEFENSE (ACQUISITION &  
TECHNOLOGY)


SUBJECT: Report of the Defense Science Board Task Force on the  
Deep Attack Weapons Mix Study (Phase I)

Attached is the report of the Defense Science Board Task Force on the Deep Attack Weapons Mix Study (DAWMS) (Phase I). The Task Force was charged to provide an independence assessment of the analytical tools and models employed in the DAWMS effort.

The significant issue illuminated by the Task Force is the great challenge in realistically modeling large-scale joint military operations against opposing forces; and then drawing acquisition conclusions from the results. A number of factors contribute to this difficulty, including:

- models require an adequate sample of "ground truth" data for verification and validation, and with recent military operations employing new technology, weapons, and tactics with each new engagement such stationary data is not available;
- the models must represent not only the physical relationships constraining combat, but also the vagaries of human behavior and command decision making;
- the models must encompass not only realistic situations, e.g. involving underground facilities, WMD, information warfare and so on, but also an adequate variety of situations, and there is typically extreme sensitivity to initial conditions leading to radically different outcomes;
- making acquisition choices based on the results of the models depends, in part, on realistic projections of future costs not only for the elements included in the models but also related support costs, alternative uses for the elements, and so on;
- making acquisition choices based on the results of the models depends on our value structure for alternative outcomes, including political and social considerations involving deterrence, loss of life, collateral damage, and so on.

In sum, while the DAWMS effort is being conducted with the best available methods, our confidence in the modeling results must be limited, and our conclusions and acquisition plans must be shaped by military experience and common sense. It is important for the Department to move forward with the development of greatly improved approaches for modeling such large-scale operations. Only by such an advance will it be possible to evaluate the capabilities of various force-structure options as well as the impact of new tactics and weapon systems.



Craig I. Fields  
Chairman



OFFICE OF THE SECRETARY OF DEFENSE

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DEFENSE SCIENCE  
BOARD

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Final Report of the Defense Science Board Task  
Force on the Deep Attacks Weapons Mix Study

Attached is the final report of the Defense Science Board Task Force on the Deep Attack Weapons Mix Study (DAWMS). The Task Force was charged to provide an independent assessment of the analytical tools and models employed in the DAWMS effort.

The significant issue that the Task Force discovered in their review of DAWMS methodology is the great difficulty in realistically modeling large-scale joint military operations against opposing forces. As a result, the Task Force believes that it is important for the Department to move forward with the development of greatly improved approaches for modeling such large-scale operations. Only by such an advance will it be possible to evaluate the capabilities of various force-structure options as well as the impact of new tactics and weapon systems.

A handwritten signature in cursive script, reading "Walter Morrow", is positioned above the typed name.

Walter E. Morrow, Jr.  
Chairman

**REPORT OF THE  
DEFENSE SCIENCE BOARD TASK FORCE  
ON  
  
DEEP ATTACK WEAPONS MIX STUDY  
(DAWMS)**

**1 January 1997**

**Office Of the Under Secretary of Defense for  
Acquisition and Technology  
Washington, D. C. 20301-3140**

This report is a product of the Defense Science Board (DSB). The DSB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. Statements, opinions, conclusions and recommendations in this report do not necessarily represent the official position of the Department of Defense.

## **OVERVIEW OF TASK FORCE REPORT**

- **BACKGROUND**
  - . **TASK FORCE MEMBERSHIP, TASKING, MEETING/BRIEFINGS**
  - . **REVIEW OF DAWMS METHODOLOGY**
    - **ASSUMPTIONS**
      - . **SCENARIOS**
      - . **LOGISTICS**
      - . **PLATFORM CHARACTERISTICS**
      - . **WEAPON PERFORMANCE**
    - **MODELS**
    - **COSTING APPROACH**
  - . **OBSERVATIONS**
  - . **SUGGESTIONS**
  - . **EXECUTIVE SUMMARY**

DAWMS-02B-TF-RPT-01

The report of the Task Force is partitioned into separate sections dealing with the origins and character of the DAWMS study, the composition and tasking of the Task Force, a review of the three components of the DAWMS study (namely input assumptions, structure and approach of the models used, and the approach to costing of force options).

The report finishes by making some observations on each of the methodology components listed above as well as making some suggestions on how to improve the process of evaluating different military force structures.

## BACKGROUND

- DOD IS CURRENTLY CONDUCTING A STUDY OF DEEP ATTACK WEAPON AND PLATFORM ALTERNATIVES
- THE STUDY IS A FOLLOW-ON TO THE CONGRESSIONALLY-DIRECTED HEAVY BOMBER STUDY COMPLETED IN MAY 1995.
- PART I OF DAWMS IS TO IDENTIFY THE APPROPRIATE MIX OF DEEP ATTACK WEAPONS FOR 1998, 2006, AND 2014, GIVEN THE CURRENT FORCE STRUCTURE
- PART II IS TO EXAMINE FORCE STRUCTURE TRADEOFFS GIVEN ADVANCES IN THE QUANTITY AND QUALITY OF DEEP ATTACK MUNITIONS  
IN ADDITION, THE IMPORTANCE OF ALTERNATIVE MISSIONS FOR DEEP ATTACK FORCES ARE TO BE EXAMINED
- PART I IS SCHEDULED FOR COMPLETION IN THE FALL OF THIS YEAR. PART II IS TO BE COMPLETED EARLY IN 1997.

DAWMS-OSB-TT-RPT-02

As a part of the Congressional debate on the possibility of further B-2 production in 1994, a heavy bomber study was mandated by Congress. This study was completed in May 1995. It concluded that U.S. deep conventional strike capabilities could best be served by expenditures on precision weapons rather than further purchase of B-2 bombers.

As a result, a study of the optimum mix of weapons to be procured was undertaken late in 1995 by OSD. The actual study was undertaken by J-8 in the Joint Staff.

During further Congressional debates on the issue of further acquisition of B-2s in the Spring of 1996, the Administration agreed to initiate a study of the optimum mix of deep strike platforms including current and B-2 bombers, tactical air, naval air, long-range missiles (land- and sea-based), and helicopters.

This latter study was appended to the DAWMS weapons study as a second phase also to be carried out by J-8.

Completion of the first, or weapons, phase was to be by September 1996 and the second, or platform, phase by the end of winter 1996/97.

As part of the agreement with Congress, the Department agreed to have the Defense Science Board (DSB) review the methodology employed in the DAWMS study.



## **TASK FORCE OBJECTIVES**

- **PROVIDE AN INDEPENDENT ASSESSMENT OF THE ANALYTIC TOOLS AND MODELS USED IN THE DAWMS EFFORT FOR:**
  - **COMPARISONS OF DEEP ATTACK WEAPONS ALTERNATIVES  
(PART I OF DAWMS - NOW UNDER WAY)**
  - **COMPARISON OF DEEP ATTACK PLATFORM ALTERNATIVES  
(PART II OF DAWMS - TO START IN THE SUMMER '96)**

DAWMS-DSB-TF-RPT-01

A Terms-of-Reference for the DSB Task Force was prepared by the DOD Director of Program Analysis and Evaluation with the concurrence of the Under Secretary of Defense for Acquisition and Technology. A copy is attached as Appendix 1.

The DSB Task Force is charged with an independent assessment of the analytic tools and models used by the DAWMS study. The Task Force is to examine the analysis developed in Part 1 (Deep Strike Weapons Optimization) and prior to Part 2 (Deep Strike Force Structure Tradeoff), to examine the soundness of the analytic approach proposed for that effort.

The Task Force will be sponsored by the Under Secretary of Defense (Acquisition and Technology) with Professor W. E. Morrow as Chairman.

The final report is to be delivered in the Fall of 1996.

## **DSB DAWMS TASK FORCE MEMBERSHIP**

**CHAIR:** PROF. WALTER E. MORROW, JR., DSB

**MEMBERS:** GEN MICHAEL P. CARNS, USAF (RET)  
DR. JOHN D. CHRISTIE, SENIOR FELLOW, LMI  
ADM LEON A. EDNEY, USN (RET)  
MGEN RAY FRANKLIN, USMC (RET)  
MR. ROBERT J. MURRAY, PRESIDENT, CNA  
MR. MICHAEL D. RICH, EXEC. V.P., RAND  
GEN JOHN W. VESSEY, JR., USA (RET)

**EXEC. SECRETARY:** DR. J. MICHAEL GILMORE, OSD/PA&E

**DSB SECRETARIAT:** LTC 'T' VANHORN, USA

**REVIEWER:** HON HAROLD BROWN, CENTER FOR STRATEGIC &  
INTERNATIONAL STUDIES

DAWMS-DSB-TF-RPT-04

Under the direction of the Under Secretary, the Task Force was organized to have membership consisting of retired senior flag officers from each of the Services to include the Marines. In addition, membership included senior civilian analysts associated with the Services.

Dr. J. Michael Gilmore from OSD/PA&E served as Executive Secretary.

MEETING SCHEDULE	
JULY 18	WASHINGTON, D.C. (PENTAGON) BRIEFINGS ON PART I METHODOLOGY DISCUSSIONS
AUGUST 13 & 14	NEWPORT BEACH, CA (BECKMAN CENTER) BRIEFINGS ON PART II PLANS DISCUSSIONS
SEPTEMBER 4	WASHINGTON, D.C. (PENTAGON) INTERIM REPORT PREPARATION
SEPTEMBER 24	WASHINGTON, D.C. (PENTAGON) INTERIM BRIEFING TO UNDER SEC. KAMINSKI, AND MR. LYNN, DIRECTOR PA&E
OCTOBER 8	WASHINGTON, D.C. (PENTAGON) BRIEFINGS ON PART1 RESULTS, PART 2 PLANS

DAWMS-DDB-TF-RPT-04

An initial meeting was held 18 July 1996 in the Pentagon to review the Heavy Bomber Study and Part 1 of the DAWMS study. This was followed by a two-day meeting, 13-14 August 1996, at the Academy of Science/Engineering Beckman Center at Newport Beach, CA. At this meeting results from Part 1 were reviewed, additions of low-observables and surveillance models were reviewed, as well as plans for Part 2. Finally, comments on DAWMS from each of the Services including the Marines were heard.

On 4 September 1996 the Task Force met to prepare its report.

An Interim briefing was given on 24 September 1996 to Under Secretary Paul Kaminski and Director of Program Analysis & Evaluation, Bill Lynn. Further briefings were given to the Task Force on 8 October 1996 concerning results of Part 1 of DAWMS as well as plans for the future.

## BRIEFINGS TO DAWMS METHODOLOGY DSB TASK FORCE

7/18	<ul style="list-style-type: none"> <li>- REVIEW OF THE DOD HEAVY BOMBER STUDY</li> <li>- COMPARISON OF OTHER BOMBER STUDIES</li> <li>- DAWMS PART I METHODOLOGY</li> <li>- DAWMS PART I ANALYSIS TOOLS</li> <li>- TACWAR</li> <li>- WORRM</li> </ul>	DR. KOLEZAR, IDA MR. BEXFIELD, IDA CAPT MILLER, ET AL, J8 COL GEORGE, J8 DR. KOLEZAR, IDA
8/13	<ul style="list-style-type: none"> <li>- STEALTH UPDATE</li> <li>- TACWAR INPUT DAWMS</li> <li>- WORRM CALIBRATION AND MODEL DETAILS</li> <li>- C4ISR IMPLEMENTATION</li> <li>- PART 2 METHODOLOGY</li> <li>- PART 2 COSTS</li> </ul>	COL CEDEL, ASD COL GEORGE, JCS (J-8) COL GEORGE, JCS (J-8) DR. KOLEZAR, IDA DR. GILMORE, ODP&E COL DURHAM, ODP&E
8/14	<ul style="list-style-type: none"> <li>- NAW COMMENTS</li> <li>- ARMY COMMENTS</li> <li>- AIR FORCE COMMENTS</li> <li>- MARINE CORPS COMMENTS</li> <li>- DISCUSSION</li> </ul>	CAPT NOONAN, OPNAV N88 COL FLORIS, ODCSOPS COL O'BRIEN, AF/XO-DAG LTCOL GOULD, HQ MC DR. BROWN, DSB REVIEWER
9/4	<ul style="list-style-type: none"> <li>- PREPARATION OF THE REPORT</li> <li>-</li> <li>-</li> </ul>	DSB TASK FORCE
10/8	<ul style="list-style-type: none"> <li>- PART 1 RESULTS</li> <li>- C4ISR IMPLEMENTATIONS</li> <li>- SERVICE CONCERNS</li> <li>- JWARS</li> </ul>	COL GEORGE COL CEDEL KEN WATMAN LTC PROSSER

DAWMS-DSB-TF-RPT-06

The Task Force was briefed on 18 July 1996 on the predecessor Heavy Bomber Studies as well as the DAWMS Part 1 (weapons optimization) methodology/models by the J-8 DAWMS leadership as well as by IDA staff members who were assisting them.

On 13 August 1996 additional briefings to the Task Force were held on (1) augmentations to the TACWAR model, (2) stealth issues and surveillance C4ISR modules. In addition, the Part 2 methodology (deep-strike platforms analysis) was described along with preliminary information on force costing approaches.

On 14 August 1996 comments on the DAWMS study were heard from the Navy, Army, Air Force, and the Marines. Finally, on 14 August 1996, Dr. Harold Brown joined the Task Force as a DSB reviewer to give some suggestions on the Task Force review.

The 4 September meeting was devoted to preparation of the report.

The 8 October briefings were arranged at the suggestion of Dr. Kaminski and Mr. Lynn in order to hear about preliminary results of Part 1 as well as plans for future DAWMS activities.

## DAWMS ASSUMPTIONS

### - SCENARIOS

- 2 MRC(s) STAGGERED IN TIME
- VARIOUS WARNING TIMES
- SOUTHWEST AND NORTHWEST ASIA USED AS SPECIFIC SETTINGS
- 1998, 2006, 2014 TIME EPOCHS
- (MANY SA-10s IN 2014 SOUTHWEST ASIA THREAT)
- CHEMICAL WARFARE ATTACKS AS EXCURSIONS
- CURRENT AND PROGRAMMED U.S. FORCE STRUCTURE IN PART 1 (WEAPONS OPTIMIZATION)
- LOGISTICS BASED ON CURRENT AND PROGRAMMED SEA/AIR CAPABILITIES
- U.S. FORCE STRUCTURE DECREMENT AS EXCURSIONS IN PART 2
- ADDITIONAL WEAPONS AS EXCURSIONS IN PART 2
- B-2 FORCE ADDITIONS AS EXCURSIONS IN PART 2

DAWMS-030-TT-APT-07

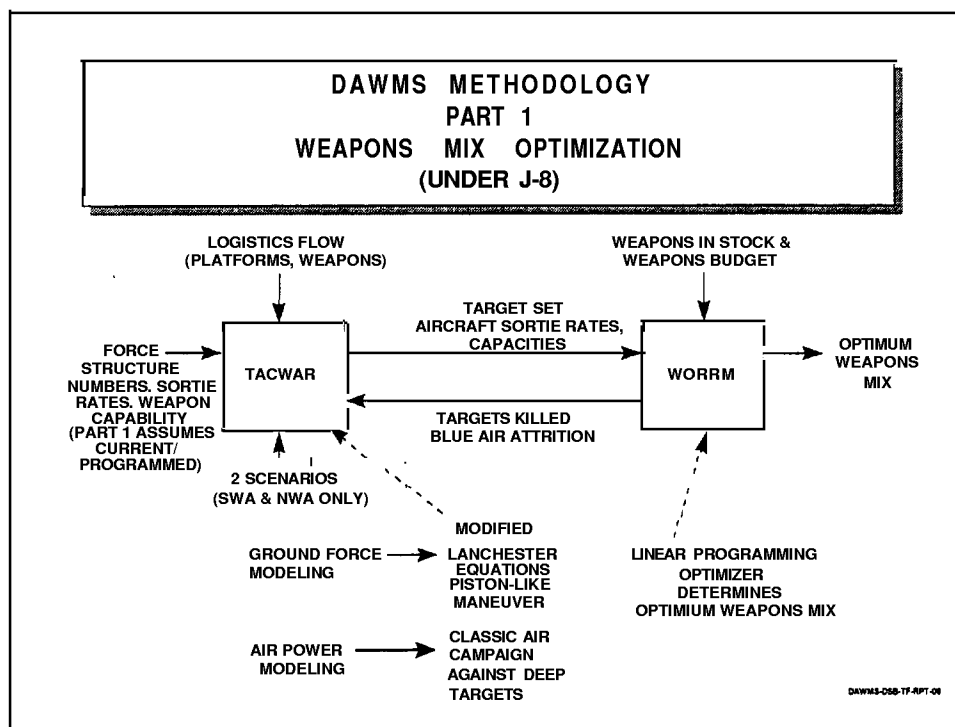
The basic setting of the DAWMS study is that of a two regional (SWA, NEA) contingency crisis such as was used in the Bottom-Up Review. No other settings were examined either of smaller contingencies or of larger scale conflicts. A variety of fairly short warning times (5 to 10 days as well as a zero warning excursion) were planned to be examined.

Time epochs of 1998, 2006, and 2014 will be examined. To date, Part 1 results center on 2006 epoch while plans for Part 2 cover 2006 and 2014. Chemical attacks are treated as excursions.

Significant SA-10 defenses in SWA postulated by DIA have drawn considerable comment from DAWMS participants. In addition, the use of extensive underground shelters by NEA reserve forces has drawn comment.

The U.S. force structure using in Part 1 is that current and programmed. The logistics (ability to deliver forces to theater) is based on current and planned air/sea lift.

In Part 2, modifications downward in force structure (described in later viewgraph), as well as upward levels of B-2 forces, are employed together with several levels of weapon inventories.



Basically the same computer/mathematical models are used in both DAWMS Part 1 and Part 2 with different force structure inputs. Two separate models are used together. The first and by far the oldest model is TACWAR.

This model has been in existence for a number of years and models a large-scale conflict by means of two-sided modified-Lanchester equations (simplified form given on next viewgraph) for the ground campaign and has had added to it an air campaign in which air attacks are mounted on a defined set of ground targets as limited by numbers of aircraft, sortie rates, and weapon quantities and capabilities.

TACWAR outputs in terms of aircraft attrition, and target kills by ground systems are sent to WORRM. This model is a one-sided linear program optimizer of a classical form to determine the optimum mix of weapons in order to maximize target kills. WORRM is used interactively with TACWAR in that its output, in the form of targets killed, is fed back to TACWAR to produce a two-sided air/ground war.

## DAWMS MODELS

### - TACWAR

- DEVELOPED OVER 15 YEARS
- TWO-SIDED LANCHESTER GROUND-WAR MODEL COMBINED WITH DEEP AIR WAR
- GROUND-WAR MODEL USES MODIFIED LANCHESTER EQUATIONS TO CAUSE FEBA MOVEMENT AND FORCE LOSSES IN EACH OF A SERIES OF PARALLEL PISTON-LIKE SECTORS

BASIC EQUATIONS:

$$\frac{dR}{dt} = -dB ; \quad \frac{dB}{dt} = -rR$$

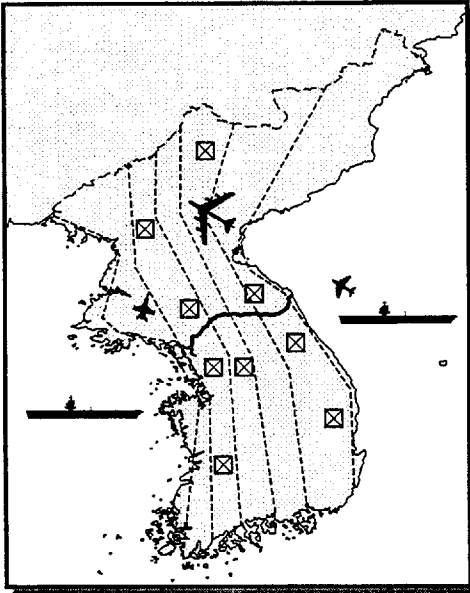
- MANUAL INTERVENTION AND JUDGEMENT IS USED TO INTRODUCE ADDITIONAL MANEUVER AS NECESSARY
- THE ORDER OF THREE WEEKS PER RUN IS CURRENTLY REQUIRED ALTHOUGH THE COMPUTER TIME IS ONLY A FEW HOURS

DAWMS-058-TP-4PT-09

The TACWAR model employs a modified form of Lanchester equations which are shown above. These equations model the losses of two engaged forces as proportional to the size of the opposing force multiplied by an effectiveness factor. They result in an exponential decay in the two force levels with time. No maneuver is inherent in the original formulation. In the case of TACWAR, movement in the FEBA is introduced when sufficient differences in force levels exist.

Since ground maneuver in TACWAR is limited to a piston-like motion in adjacent columns normal to the FEBA, manual intervention by experienced military is employed to resolve problems and to introduce more complex maneuvers but not including flanking or encirclement. The average run times of TACWAR are of the order of several hours, but, in reality, extend to as much as three weeks because of the manual interventions and their adjudication.

## MODELS TACWAR



- **CONTROL**
  - AIR: SORTIE RATES, APPORTIONMENT TO MISSIONS, AND ALLOCATION TO REGIONS OF THE BATTLEFIELD AND SUB-ALLOCATION TO TARGET TYPES
  - GROUND: UNIT MOVEMENT ORDERS AND OBJECTIVES
- **AIR**
  - 40 AIRCRAFT TYPES, 50 MUNITION TYPES
  - TIME-PHASED FLOW TO BASES
  - AVAILABLE AIRCRAFT ALLOCATED TO 12 MISSIONS IN AIR-TO-AIR, AIR-TO-GROUND, AND SEAD MISSION AREAS
  - AIRCRAFT ATTRITION DUE TO AIR-TO-AIR ENGAGEMENTS, FIXED & UNIT AIR DEFENSES, AND KILLED ON THE GROUND
- **GROUND**
  - 12 GENERIC PLATFORM TYPES
  - UNITS CHARACTERIZED BY WIDTH, DEPTH, MOVEMENT, etc.
  - WEAPON CHARACTERISTICS CAPTURED BY ENGAGEMENT RATES, ALLOCATIONS TO TARGETS, AND PKs AS FUNCTION OF POSTURE
  - FEBA MOVEMENT AND ATTRITION BASED ON FORCE RATIO

283584-2

The piston-like action of TACWAR is shown in the viewgraph. In each column (piston) a separate Lanchester equation is evaluated for each 12 hours of battle. As the result of this computation, the balance of residual force levels is determined. A decision is then made to declare a stalemate, or, if the force ratios are sufficiently large, movement of the FEBA is declared. If one piston movement is far ahead of its neighbors, manual intervention is required to rebalance the front.

In the air, many types of aircraft and weapons are modeled from various bases to targets banded by range. Depending on the weapon capabilities, ground targets/enemy air are killed or not, and aircraft are lost both to enemy action as well as to normal operations.



## DAWMS MODELS (Cont'd)

### - WORRM

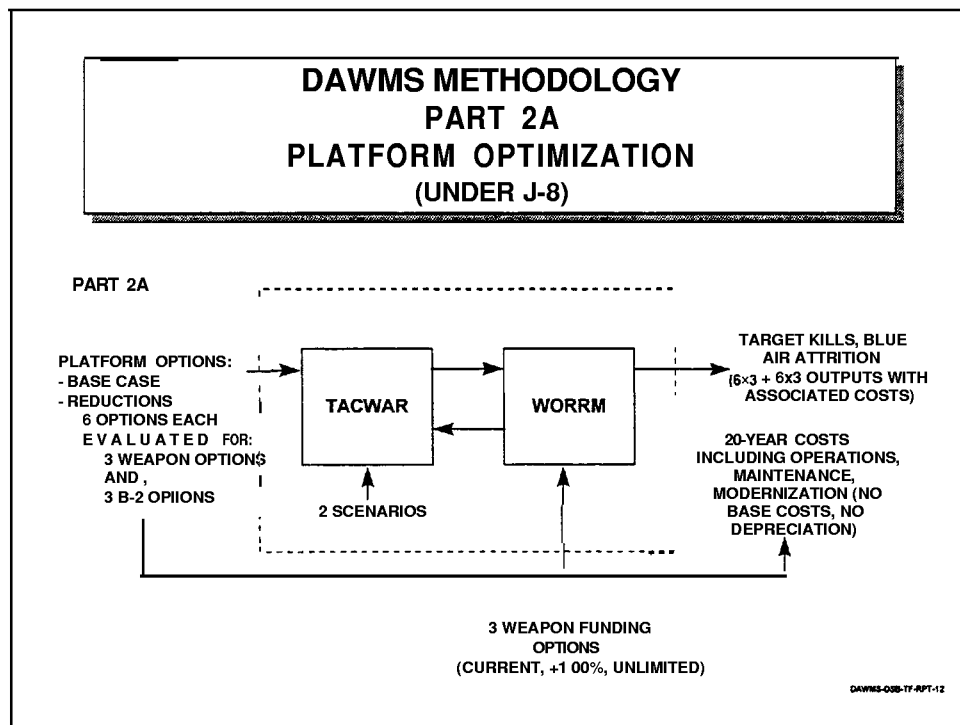
- A ONE-SIDED LINEAR PROGRAM OPTIMIZER WHICH TAKES INPUTS FROM TACWAR IN THE FORM OF AIR-TARGET REQUIREMENTS, GROUND KILLS OF AIR TARGETS, SORTIE RATES, GROUND-TARGET KILLS PER SORTIE
- USES STANDARD LINEAR PROGRAM OPTIMIZER "CPLEX"
- OPTIMIZES WITH MULTIPLE CONSTRAINTS AND BOUNDS ON WEAPON PROCUREMENT COSTS AND CURRENT INVENTORY
- PRODUCES A LIST OF NUMBERS OF WEAPONS OF EACH TYPE TO MAXIMIZE THE QUANTITY OF TARGETS KILLED WEIGHTED BY TARGET VALUE
- IT OPERATES WITH NO INTERVENTION AND TAKES SEVERAL HOURS PER RUN

DAWMS-OSB-TF-RPT-11

The WORRM model carries out a one-sided optimization of weapon mix, and, in the process, delivers back to TACWAR targets that it has been able to kill for use in the two-sided conflict modeled by TACWAR.

It employs a widely used software package, CPLEX, to determine the optimum mix of different types of air-to-ground weapons to maximize the sum of target kills weighted by value. A number of constraints and tabular inputs are used in the optimization including one on total weapon expenditures. Others relate to aircraft sortie rates/ load outs, range of platforms and weapons, probability of kill, etc.

It operates without intervention and requires several hours per run.



In Part 2A of the DAWMS study the ability of various deep strike force structures are to be examined for effectiveness and cost. The TACWAR – WORRM configuration previously described is planned to be used for these studies. The same scenarios as in Part 1 are to be used with the same logistics limitations. However, in Part 2A, variations on the force structure upwards and downwards together with large variations in weapons inventories are to be investigated. Starting with the Base case used in Part 1, a total of 6 decremented deep-strike forces are to be examined with three variations of weapons inventories. Thus, a total of 6x3 or 18 cases will be modeled, with costs calculated for each case together with outputs of deep strike targets killed. It is not clear whether outcomes of the ground campaigns will be also available. In addition to these cases, additional runs will be made with various additions to the B-2 bomber force.

The next viewgraph will show the various cases to be examined.

## PART 2 FORCE STRUCTURE OPTIONS (FSOs)

I. BASE CASES				II. REDUCTIONS		CASES	
<b>BUR FORCES</b>  -WITH AND WITHOUT OPTIMUM MUNITIONS FROM FROM DAWMS 1  -WITH AND WITHOUT UNFUNDED CONVENTIONAL BOMBER UPGRADES				BOMBERS	1/2 B-1s	1 CV/CVW	
				SEA-BASED TACAIR		1 CV/CVW	
				LAND-BASED TACAIR		1 CV/CVW	
				HELICOPTERS	10% FORCE	20% FORCE	30% FORCE
				SURFACE-SURFACE MISSILES/ARSENAL SHIP INVENTORIES	(DETERMINED USING DAWMS 1 RESULTS)		
				Shaded cases identical in II and IV			
III. MUNITIONS TRADEOFF ANALYSIS	OPTIMUM, CURRENT BUDGET	OPTIMUM, CURRENT BUY	OPTIMUM, CURRENT BUDGET BUY	IV. B-2 TRADEOFF ANALYSIS	+20 B-2s	+40 B-2s*	+60 B-2s*
BOMBER REDUCTIONS	X	X	X	BOMBERS	1 CV/CVW	N/A	
SEA-BASED TACAIR REDUCTIONS	X	X	X	SEA-BASED TACAIR	1 CV/CVW	2 CV/CVWs + 2 TFWEs	
LAND-BASED TACAIR REDUCTIONS	X	X	X	LAND-BASED TACAIR	1 CV/CVW	2 TFWEs	
HELICOPTER REDUCTIONS	X	X	X	HELICOPTERS	10% FORCE	N/A	N/A
SURFACE-SURFACE MISSILES/ARSENAL SHIP INVENTORIES	N/A	N/A	N/A	SURFACE-SURFACE MISSILES/ARSENAL SHIP INVENTORIES	N/A	N/A	N/A
				*Assumes all bombers upgraded			

DAWMS-CSD-TF-8PT-13

DAWMS-030-TF-RPT-13

The various force level decrements and B-2 augmentations are shown by shading in the viewgraph above. Six different decrements of deep strike forces have been chosen for analysis. Three levels of weapon inventories are to be used with each force option thus resulting in 18 different options to be evaluated and costed.

In addition, two levels of B-2 augmentations are to be evaluated with each of the six force decrements equipped with nominal weapon levels. This will result in an additional twelve outputs.

The Task Force believes that this set of force options is reasonable and appropriate for the Part 2 DAWMS effort.

**DAWMS METHODOLOGY**  
**PART 2B**  
**MISSION ASSESSMENTS**  
**(UNDER SERVICES)**

**- EXAMINATION OF OTHER MISSIONS FOR DEEP-STRIKE FORCES**

**- STUDY ASSIGNMENTS**

- |   |                  |
|---|------------------|
| - THEATER AIR OPERATIONS<br>(CAS, AIR DEFENSE, SURV., ETC.) | AIR FORCE (RAND) |
| - NAVAL WARFARE<br>(SEA CONTROL, FLEET DEFENSE, ASW, ETC.)  | DoN (CNA)        |
| - CLOSE COMBAT  | ARMY (TRADOC)    |
| - PRESENCE (OVERSEAS)                                       | DoN (CNA)        |
| - NUCLEAR DETERRENCE  | OSD              |

**- MULTIPLE MEASURES OF MERIT**

TO BE CONSIDERED, BUT NOT YET ESTABLISHED

DAWMS-CDS-TP-RPT-14

The Services have noted that the deep strike forces being decremented in Part 2A have other important roles than deep strike. As a result, in Part 2B of DAWMS, the Services are to examine the impact of force decrements on other missions such as those shown above. Each mission area has been assigned to an appropriate Service and they are free to use whatever models they think appropriate to make the assessment. As yet, there have not been any measures of merit established for these studies.

## **DAWMS COSTING OF FORCE STRUCTURE OPTIONS**

### **- DAWMS FORCE OPTION COSTS INCLUDE THE FOLLOWING PRICED OVER 20 YEARS**

- OPERATIONS INCLUDING PERSONNEL, FUEL/CONSUMABLES, MAINTENANCE
- BASE SUPPORT
- TRAINING OF REPLACEMENT AIRCREWS
- BASE CLOSURES
- 20 YEARS OF MODERNIZATION

### **- COSTS NOT INCLUDED:**

- DEPRECIATION COSTS OF FORCE PLATFORMS
- DEPRECIATION COSTS OF BASES
- CARRIER TASK FORCE SUPPORT SHIPS (NAVY)
- AIR FORCE SUPPORT AIRCRAFT (AWACS, EW, SURVEILLANCE, ETC)
- SHIPS FOR SURFACE-TO-SURFACE MISSILES

DAWMS-DSB-TF-RPT-15

Current plans are to evaluate force structure options by calculating the 20-year costs of each force option to include operational and direct-support costs as indicated above. A 20-year modernization cost has been included as a surrogate for force depreciation.

A number of other costs have not been included. These include the actual depreciation (wearout) costs of the force options. The depreciation costs of the CONUS and overseas air bases have also not been included. In addition, the costs of secondary support systems have not been included. In some cases, these systems are necessary for air platforms to penetrate successfully. In other cases, they are universally needed for surveillance and acquisition of targets.

Finally, the costs are fully attributed to the deep-strike mission, whereas the forces considered may have other significant other missions.

**INITIAL RESULTS AND FUTURE PLANS  
(8 OCT 96 BRIEFINGS)**

- DAWMS PART 1 (WEAPON OPTIMIZATION) IS NOW OPERATING SATISFACTORILY. INITIAL RESULTS INDICATE THE NEED TO REFINE CERTAIN CONSTRAINTS IN WORRM TO AVOID ANALAMOUS RESULTS
- PLANS WERE PRESENTED FOR RUNNING ADDITIONAL CASES WITH VARYING ASSUMPTIONS AND AN ADDITIONAL SCENARIO INVOLVING AN MRC WITH NO IN SITO U.S. FORCES AT THE TIME HOSTILITIES ARE INITIATED
- ACCESS TO BOTH AIR FORCE AND NAVY SAR DATA IS IN PROCESS

DAWMS-CDS-TF-RPT-18

Part 1 Results: On the first topic COL George reported that Part 1 results had been obtained for the year 2006 West first/East later case. Some of the weapon allocations resulting from this run had raised questions, and, as a result, some of the constraints in WORRM were being reviewed. COL George also reported on the efforts to get the IDA and PA&E TACWAR models to produce the same results for the same input conditions. It now appears that there will be an attempt to analyze many of the cases suggested by the Task Force including an MRC scenario in which no U.S. forces or prepositioned equipments are present at the beginning of hostilities. This is going to take considerable time to accomplish. It is possible that the Part 1 effort could easily take to the end of the year and perhaps beyond. It also seems clear that Part 2 analysis (Platforms) will take well into the next year to accomplish.

Access to SAR Information: A memo-of-understanding has been signed which will result in a significant number of analysts being given clearances into SAR data from both the Air Force and the Navy. About 30 on 125 requests have been granted to date as well as the clearance of space at IDA.

Update of the Efforts to Improve Modeling of C4ISR: Considerable progress was reported of better modeling of C4ISR in TACWAR and WORRM. The current modeling incorporates the effects of varying capability to detect, classify, and identify targets. It appears, however, that the complete modeling of BDA, particularly its timeliness, is yet to be achieved.

**INITIAL RESULTS AND FUTURE PLANS  
(8 OCT 96 BRIEFINGS)  
CONTINUED**

- A REVIEW OF SERVICE CONCERNS INDICATED THAT MOST ISSUES HAD BEEN SETTLED. A FEW TOPICS WERE STILL OF CONCERN:
  - MODELING OF ATACMS AND THE ARSENAL SHIP
  - AIR SORTIE RATES DURING THE 2ND PHASE OF THE CAMPAIGN
- SEVERAL-YEAR PROGRAM TO DEVELOP AN ADVANCED LARGE-SCALE COMBAT MODEL HAS BEEN INITIATED AS A REPLACEMENT FOR TACWAR

DARMS-DSB-TT-RPT-17

Status of Services's Concerns: Ken Watman reported on the current status of Services's concerns about the TACWAR modeling. He reported that many of the earlier concerns of the Services had been met. There were still some items of concern however:

Army is still concerned about the adequateness of modeling the ATACMS surface-to-surface missile.

Air Force: is concerned about the drop in kill rates during the 2nd phase of the conflict.

Navy is also concerned about the modeling of the arsenal ship and its effectiveness.

Marines: apparently still did not have any concerns.

Plans for the Development of JWARS: Lt. Col. Prosser reports on longer-term plans to develop a new modeling capability called the Joint Warfare System. He said that this effort had been under way for about one year and that it was motivated by the Vice Chairman, Joint Chiefs of Staff, during a briefing of a recent mobility study, when he raised questions about the quality of and degree of new technology (e.g., intelligence processing, smart weapons, etc.) included in the combat models being used to evaluate forces and generate movement requirements. The JWARS effort is in the definition/contracting phase at this time.

## INTRODUCTORY OBSERVATIONS

- MILITARY FORCES SHOULD BE DESIGNED TO HANDLE A RANGE OF THREATS TO NATIONAL SECURITY WITH SUFFICIENT ROBUSTNESS TO RESPOND TO UNPREDICTED EVENTS AS WELL AS THOSE PREDICTED
- MODELING OF FUTURE MILITARY ENGAGEMENTS SHOULD REALISTICALLY REPRESENT MODERN COMBAT TACTICS
- ANALYTIC MODELS CAN SHOW HOW OUTCOMES VARY WITH CHANGES IN CIRCUMSTANCES AND DETAILS
- BUT THERE IS A GREAT DEAL OF UNCERTAINTY ABOUT THE CIRCUMSTANCES AND DETAILS OF FUTURE CONFLICTS

DAWES-088-77-RPT-18

The fundamental thought of the first point is that military forces should not be point designed to be optimum for one or two very specific scenarios such as those identified in the Bottom Up Review of a few years ago. Rather they should be designed for a spectrum of possible scenarios including those which now seem unlikely as for instance the rise of a peer competitor. This is important because of the rather long time it takes for build and train armed forces - some ten to twenty years.

Modern combat involves maneuver tactics including encirclement, deep penetration, deep attack stand-off fires as well as non-linear warfare. Analytic models that could represent these tactics would be useful, but currently do not exist.

Analytic models can indicate how the outcome of a conflict might vary with changes in the input assumptions and scenario. They are less likely to be able to give absolute answers about the precise level of military forces needed for a particular challenge to national security.

Finally, it should be obvious, from even a brief study of history, that it is next to impossible to predict even the major parameters of possible future conflicts to say nothing of the details.



## **OBSERVATIONS ON ASSUMPTIONS AND SCENARIOS**

- **UNCERTAINTIES REQUIRE EXPLORATION OVER WIDE VARIATIONS IN ALL IMPORTANT INPUTS /ASSUMPTIONS**
- **DAWMS PART I (WEAPONS OPTIMIZATION) EXAMINES A LIMITED SET OF SCENARIOS (LOCATIONS, THREAT, ETC.) AND VARIATIONS IN ASSUMPTIONS (WARNING TIMES, C4ISR, STEALTH, ETC.)**
- **PLANS FOR DAWMS PART 2 (PLATFORM ALTERNATIVES) SHOW AN AWARENESS OF THESE LIMITATIONS BY INCLUSION OF SEPARATE OVERALL ASSESSMENTS OF MULTI-MISSION CAPABLE PLATFORMS, BUT THE OVERALL PART II APPROACH STILL DOES NOT OVERCOME THESE LIMITATIONS**
- **TO ADEQUATELY TEST THE ROBUSTNESS OF THE U.S. DEEP ATTACK CAPABILITIES, IT WILL BE NECESSARY TO EXAMINE:**
  - **A BROADER SET OF PLAUSIBLE POLITICAL - MILITARY SCENARIOS**
  - **A WIDE RANGE OF VARIATIONS, IN KEY PARAMETERS (C4ISR, STEALTH, WARNING TIME, LOGISTICS FLOW, COSTS, ETC.) FOR EACH SCENARIO**
  - **USE OF ALTERNATIVE APPROACHES / MODELS**

DAWMS-DSB-TF-RPT-19

Because of uncertainties concerning possible future conflicts, it is necessary to test analytic models of such conflicts over a wide range of inputs and assumptions in order to understand the dependence of outcomes on those inputs.

The DAWMS Part 1 Study (weapon optimization), examined only a limited set of scenarios namely two - South West Asia and North East Asia. In addition, there has been time to examine only a few variations in assumptions such as different warning times, different C4ISR capabilities, and as yet no detailed information on stealth.

The plans for the DAWMS Part 2 Study show concern over these Part 1 limitations in that additional variations are planned as well as the inclusion of mission assessments which will examine the importance of other roles for the various deep strike forces. However, the overall DAWMS Part 2 approach is judged to be limited in its approach. For instance, it does not plan to investigate other scenarios which are more likely in 2006 and especially in the 2014 time period.

Therefore, the Task Force believes that to understand the effectiveness of various deep attack force options or combinations thereof, it will important to examine a much broader set of international security scenarios. For each of those situations, a wide range of basic assumptions concerning key parameters such as (C4ISR, warning time, logistics flow, etc) will have to be examined. In addition, it will be important to examine in some analytic detail, the multiple roles that deep strike forces can play in the outcomes.

## OBSERVATIONS ON MODELS

THE TACWAR/ WORRM MODEL IS VERY LIMITED IN ITS REPRESENTATION OF MODERN MANEUVER WARFARE

THE CURRENT IMPLEMENTATION OF THE TACWAR / WORRM MODEL BY THE DAWMS TEAM REQUIRES MANUAL INTERVENTIONS THAT RESULT IN UP TO 3 WEEKS PER SET UP AND RUN AND THUS SIGNIFICANTLY LIMITS THE NUMBER OF PARAMETER VARIATIONS THAT CAN BE EXAMINED.

THESE LIMITATIONS ARE MARGINALLY ACCEPTABLE FOR DAWMS PART I (WEAPON MIX OPTIMIZATION) RESULTS THAT APPLY OVER THE FYDP WHICH ASSUMES CURRENT FORCE STRUCTURE

THE TACWAR / WORRM MODELING APPROACH IS EVEN LESS APPROPRIATE FOR PART 2A (PLATFORM MIX TRADEOFFS) BECAUSE THE SET UP AND RUN TIMES AS BEING IMPLEMENTED WILL NOT PERMIT SUFFICIENT EXPLORATION OF PARAMETER VARIATIONS AS WELL AS A WIDE SPECTRUM OF SCENARIOS.

FOR PART 2B (MULTI-MISSION ANALYSIS) THE MODELS AVAILABLE TO THE SERVICES ARE NOT LIKELY TO PROVIDE COMPARABLE JOINT WARFIGHTING VALUES FOR MULTIMISSION PLATFORM ASSETS. THE METHOD OF INTEGRATING RESULTS FROM THESE MODELS BY DAWMS IS NOT YET EVIDENT.

WE KNOW OF NO SINGLE MODEL THAT CAN ASSESS THE RELATIVE VALUE OF MULTIMISSION WEAPON SYSTEMS. MULTIPLE MODELS WITH COMPARABLE MEASURES OF PERFORMANCE TOGETHER WITH PROFESSIONAL MILITARY JUDGEMENT ARE NEEDED FOR THIS TASK.

DAWMS-CSS-TF-RPT-30

The Lanchester equation-based TACWAR model does not represent modern maneuver warfare tactics such as encirclement, rapid deep penetration, deception, or non linear warfare.

Because of the necessity for extensive manual intervention, the current implementation of the combination TACWAR-WORRM models used for the DAWMS effort requires as much as three weeks per run. In the time available for the DAWMS study, relatively few variations of the critical parameters can be explored.

For DAWMS Part 1 (weapon mix optimization) this is marginally acceptable except that the deep strike platforms chosen is limited to current forces plus those planned in the FYDP. This raises significant questions concerning the 2006 and 2014 year estimates.

For DAWMS Part 2A (deep strike platform trade-offs), the TACWAR-WORRM model may be even less appropriate since the limitation on the number of parameter variations will be even more restricted because of the desire to test a significant number of variations in deep strike platform combinations which have been noted earlier to be at least 18 in number. In addition, the DAWMS model is judged to be seriously deficient in modeling maneuver as well as the impact of the use of WORRM on airfields and support areas.

For the multiple mission Part 2B portion of the DAWMS effort, multiple models will be used by the Services involved. The compatibility between these models is not evident nor is it evident that a method of integrating their results is available.

Finally, it should be noted that the members of the DSB Task Force know of no existing model which can access the relative value of multimiission weapon systems over a range of conflicts.

## OBSERVATIONS ON COSTING

- IN DAWMS PART 1, A RANGE OF COST ESTIMATES SHOULD BE USED FOR PRE-PRODUCTION WEAPONS TO TEST FOR SENSITIVITY OF RESULTS TO VARIATIONS IN ACTUAL COSTS FROM ESTIMATED COSTS. EVEN FOR WEAPONS IN PRODUCTION, POSSIBLE COST VARIATIONS DUE TO CHANGES IN THE NUMBERS PURCHASED SHOULD BE INVESTIGATED.
- ALSO IN DAWMS PART 1, THE IMPORTANCE OF WEAPONS PLATFORM ATTRITION ON PREFERRED WEAPONS MIXES SHOULD BE EVALUATED IF THE VALUES OF PLATFORMS LOST THROUGH ATTRITION VARY SIGNIFICANTLY WITH DIFFERENT MIXES OF WEAPONS
- IN DAWMS PART 2A, THE WEAPON PLATFORM COSTS NEED TO BE CONSISTENT AND COMPARABLE. A RANGE OF COSTS NEED TO BE CONSIDERED WHERE THERE IS COST UNCERTAINTY SUCH AS FOR WEAPON PLATFORMS YET TO BE PRODUCED.

DAWMS-DSB-TF-RPT-21

In DAWMS Part 1, reasonably accurate costs are available for the weapons in production although variations due to production rate changes and total numbers need investigation. Where production has yet to be undertaken, some caution needs to be taken in using estimates, since these often turn out to be optimistic. Therefore a range of cost estimates needs to be used for these weapons to see if the weapons mix estimates are significantly changed should the costs of the advanced weapons turn out to be higher than estimated.

If weapons platform attrition values turn out to vary significantly for different Part 1 runs (i.e., the differences in value of platforms lost are not small compared to the assumed values for total weapons budgets), then some evaluations (possibly offline) of the importance of platform attrition or desired weapons mixes should be performed.

It should be evident that even if the models in DAWMS were able to give accurate outcomes over a range of scenarios and input assumptions, the results of the study will not be meaningful unless accurate and comparable costs can be generated for all of the various combinations of deep strike platforms. This means that a great deal of attention needs to be paid to insure that the costs of the various weapon platforms considered are comparable in all aspects such as support costs, wearout or modernization costs, as well as operations costs.

## **OBSERVATIONS ON INITIAL RESULTS AND MODIFICATIONS IN PLANS FOR DAWMS**

- THE INITIAL RESULTS FROM DAWMS PART 1 (WEAPON OPTIMIZATION ) INDICATES SUCCESSFUL OPERATION OF THE MODEL. FUTURE RESULTS WILL BE MUCH MORE MEANINGFUL IF WIDE EXCURSIONS IN ASSUMPTIONS SUCH AS WARNING TIME, IN-THEATER FORCE LEVELS, C4ISR USE OF STEALTH AIRCRAFT, AND USE OF WEAPONS OF MASS DESTRUCTION ARE ANALYZED AS CURRENTLY PLANNED
- THE EFFORT TO MAKE AVAILABLE SAR DATA IS UNDER WAY AND SHOULD PROVE HELPFUL IN ASSESSING THE VALUE OF STEALTH
- LONGER-TERM PLANS TO DEVELOP A NEW LARGE-SCALE COMBAT MODEL (JWARS) ARE VERY ENCOURAGING AND OFFER THE POTENTIAL OF OVERCOMING LIMITATIONS IN TACWAR, BUT THE NEW MODEL WILL NOT BE AVAILABLE FOR THE DAWMS

DAWMS-030-17-APT-02

The initial Part 1 DAWMS results involving the end-to-end operation of the TACWAR/WORRM model verify the end-to-end operation of the model. After some adjustments in the WORRM constraints, it should be possible to run a number of variations in assumptions. The Task Force is very encouraged that a much more extensive set of assumptions are to be run than originally planned. Efforts are under way to bring on-line IDA and PA&E TACWAR computers in order to increase capacity to run different cases.

However, even with additional capacity, it is not likely that Part 1 runs can be completed short of the end of 1996, or perhaps, even the early months of 1997. It seems clear that Part 2 runs, involving platform trade-offs, will take a number of additional months.

The availability of SAR data should make possible a number of meaningful runs to test the value of stealth.

The Task Force is very encouraged by the longer-term plans to develop JWARS, an advanced warfare modeling capability which should be capable of overcoming many of the shortcomings of TACWAR. However, it will not be developed in time for use in the DAWMS.

## GENERAL CONSIDERATIONS

- THE FUTURE IS UNCERTAIN. IN THE TIME FRAME OF DAWMS (1998, 2006, 2014) NEW COMBINATIONS OF POTENTIAL ENEMIES AS WELL AS ALLIES CAN OCCUR. IN ADDITION, A PEER COMPETITOR COULD ARISE BY 2014
- THE USE OF WEAPONS OF MASS DESTRUCTION, INFORMATION WARFARE AND OTHER ASYMMETRICAL FORMS OF WARFARE COULD ARISE IN THE DAWMS TIME FRAME
- THESE UNCERTAINTIES NEED TO BE INVESTIGATED BY A BROADER SPECTRUM OF ANALYSIS THAN IS BEING UNDERTAKEN IN DAWMS
- BECAUSE OF THESE UNCERTAINTIES, MILITARY FORCE OPTIONS SHOULD BE EVALUATED NOT ONLY FOR THEIR WARFIGHTING CAPABILITY, BUT ALSO FOR TWO QUALITIES NOT IN THE CURRENT ANALYSIS
  - DO THEY INCREASE OUR ABILITY TO SHAPE THE FUTURE INTERNATIONAL SECURITY ENVIRONMENT?
  - DO THEY PROVIDE HEDGES AGAINST UNCERTAINTIES SUCH AS THE LOCATION AND POSSIBLE FORM OF FUTURE AGGRESSION?
- DAWMS ANALYTIC APPROACH DOES NOT INCLUDE THESE BROADER EVALUATIONS

DAWMS-058-TF-RPT-03

Finally, there are a few general considerations that the Department of Defense leadership needs to address.

It should be noted first and obviously, that the future is uncertain. By the years 2006 and especially 2014 the U.S. could very well face new combination of enemies as well as new allies. It is entirely possible that a new peer competitor could arise by 2014 which could challenge the U.S. with asymmetrical forms of warfare.

By that time, threats against the U.S. mainland in the form of weapons of mass destruction, information warfare, and challenges to our sources of energy, raw material supplies, as well as markets, could emerge.

This broader spectrum of possibilities, not currently being examined in DAWMS, needs to be examined.

In view of the unpredictability of these major threats, future military force options need to be examined for two basic qualities:

- Do these hypothesized future forces increase the ability of the U.S. to shape the future international security environment by discouraging potential challengers from armed aggression?
- Do these future forces provide hedges against uncertainties such as the location and possible form of future aggression against the U. S. or its allies?

## SUGGESTIONS

- **DO NOT DEPEND ON THE INITIAL PLANS FOR DAWMS PART 2 TO PROVIDE REALISTIC INSIGHTS IN MAKING DEEP ATTACK FORCE STRUCTURE JUDGMENTS UNLESS, AS CURRENTLY PLANNED, THE STUDY IS REFOCUSED TO:**
  - **CONSIDER ADDITIONAL SCENARIOS SUCH AS:**
    - AN MRC IN A LOCATION HAVING NO IN THEATER SUPPORT (I.E. PRE POSITIONED EQUIPMENT, TAC AIR, LARGE AIRFIELDS, PORTS ETC.)
    - PEER COMPETITORS, ONE LOCATED CLOSE TO THE SEA AND THE OTHER FAR FROM THE SEA
  - **EVALUATE FOR EACH SCENARIO THE IMPACT OF DIFFERENT DEGREES OF DEGRADED C4ISR, STEALTH, WARNING TIME, AND OTHER CRITICAL PARAMETERS**
  - **MAKE AVAILABLE TO DAWMS SPECIAL ACCESS INFORMATION**
  - **PROVIDE A NUMBER OF MONTHS OF ADDITIONAL TIME TO COMPLETE THE SUGGESTED CHANGES TO PART 2**
  - **PRODUCE COMPLETE WRITTEN INTERIM AND FINAL REPORTS OF DAWMS RESULTS VS ANNOTATED VIEWGRAPHS OF RESULTS**

DAWMS-005-TF-RPT-24

The Task Force suggests that the initial plans for DAWMS Part 2 study is not likely to provide definitive answers on the best mix of future deep strike forces unless the study is refocused to overcome the limitations of the initial plans for DAWMS Part 2. The Task Force suggests a reorientation of the DAWMS Study to incorporate the following modifications:

- In order to provide and greatly improve INSIGHTS, the Task Force believes that additional scenarios need to be evaluated such as: an MRC in a location which provides very limited in-theater support in the form of prepositioned equipment, tactical airfields, large ports, etc., as well as two peer competitor scenarios, one of which is located close to the sea and the other of which is located well inland.
- Combat ability of future deep strike forces needs to be evaluated in all of these various scenarios under a variety of conditions such as a degraded C4ISR capability, decreased warning times, and various degrees of stealth.
- Make available detailed data on the stealth performance of deep attack platforms and weapons. It is important that the Deputy Secretary of Defense direct that this data be made available to the DAWMS study.
- Allocate additional time beyond that currently planned for DAWMS since one to three weeks is required for each TACWAR/WORRM run. Part 2 will need to investigate a number of additional runs involving additional scenarios and assumptions outlined above. Under these circumstances, it is unlikely that DAWMS Part 2 can be completed by the end of Winter early in 1997. A number of months of additional time is likely to be needed.
- DAWMS should record its results in the form of a series of carefully documented written reports, both interim and final, for both Part 1 results as well as Part 2 results. It is believed that such reports will provide a much clearer and less ambiguous picture of the DAWMS results than a series of viewgraph reports.

## **SUGGESTIONS (CONT'D)**

- **FOR THE LONGER TERM, SUPPORT THE DEVELOPMENT OF AN IMPROVED APPROACH FOR RAPID EVALUATION OF BROAD MILITARY FORCE STRUCTURE ISSUES. THE ONGOING JWARS PROGRAM MAY OFFER SUCH AN APPROACH.**

DAWMS-058-TF-RPT-25

The Task Force encourages the efforts of the Department to develop innovative concepts for rapid modeling and evaluation of broad military force structure issues. In particular, the Task Force supports the vigorous development by the Department of the recently initiated JWARS modeling program.